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THE EFFECT OF CLIMATE CHANGE ON THE AGRICULTURAL SECTOR IN TURKEY

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After Industrial Revolution, severe increases were experienced in fossil fuel consumption due to increased energy needs. The endless struggle of humankind for interest and his/her ignorance of environmental devastation led greenhouse gas to accumulate in the atmosphere, global warming to be experienced and, depending on this, climatic change to form. This process experienced has caused many international and national studies to be conducted in the area of climatic change related to the different disciplines, and the issue has taken place in the top orders among the leading subjects in academic platforms. This study discussed the effect of climatic change in Turkey on the agricultural sector. The sectors dealt with the study the agricultural sector, and the effects of climatic changes were aimed to be introduced with an econometric model. In agricultural sector, the effects of climatic changes from the perspective of the product productivity were analyzed by means of the agricultural sector, the effects of climatic changes from the perspective of product productivity were analyzed through Granger Causality Test. In the study, the period of 1970 -2017 was based on. The study deals with the issue on a sectorial basis; additionally, its effect is evaluated on the basis of product productivity from the original aspect of the study. Setting out from the results obtained in the study, climatic policies directed to the agricultural sector for Turkey were formed. The effects of the process on the sector were explicitly introduced. Developing climatic policies directed to this sector was targeted to contribute to the literature.

Keywords: Climate change, agricultural products, granger causality test, variance decomposition.

INTRODUCTION

Regardless of the level of development, it is frequently mentioned in the economics literature that countries can increase their development levels only if they reach their rapid growth targets. Although the necessity of achieving high growth figures in order to overcome income distribution, poverty and environmental problems has been emphasized in much literature, contrary to expectations, in today's conditions, poverty spreads to large masses, the balance in natural resources is disturbed, the income distribution inequality gap is widening day by day, and environmental pollution gains a global dimension appear to cause climate change. Contrary to expectations, this understanding has led to the beginning of a transformation process in economic policies. Traditional economic policies have been replaced by sustainable development policies that give importance to people, meet economic and cultural needs, and consider future generations.

With the emergence of the concept of sustainability, the destructive effect of capitalism in the economic policies of countries and the endless struggle of people's interests have revealed how much destruction has occurred on the environment. In particular, the deterioration of the density of natural greenhouse gases released into the air as a result of human-made pollutants, the uncontrolled accumulation of greenhouse gases in the atmosphere, the retention of short-wave solar energy entering the earth and atmosphere system and long-wave solar energy reflected from the earth in the atmosphere have caused global warming and climatic changes (Yozcu, 2011:1). The climate change experienced has different effects on a global, regional and local scale, and this difference has brought along natural events such as drought, unexpected heat waves, extreme cold, floods and deluges. In this context, the United Nations Framework Convention on Climate Change was prepared and signed in 1992, determining the general rules, principles and obligations on policies on climate change. The Convention is accepted as a

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joint agreement that reduces greenhouse gas emissions that cause climate change. In the United Nations Framework Convention on Climate Change, global climate change is defined as "a change in climate as a result of human activities that directly or indirectly degrade the composition of the global atmosphere, in addition to natural climate changes observed in comparable periods.

In this framework agreement, a non-binding obligation has been introduced for developed countries not to increase the greenhouse gas emissions they create in their industrial production, in other words, to stabilize them. Another development with a higher degree of obligation was realized within the framework of the Kyoto Protocol. According to the Kyoto protocol, obligations limiting and reducing greenhouse gas emissions have been introduced in countries that have completed or continue their industrialization process. The first obligation period of the protocol started in 2008 and 2012.

Because the issue of climate change is versatile, it is seen that many international and national studies on the subject from different perspectives have been brought to the literature in recent years (Uzmen, 2007). One of the factors changing with climate change has been the world economy. The process caused a change in the course of the economy, the formation of important cost items in the national economies, or an increase in the current cost items. This process has led to many international and national studies in different disciplines in climate change in recent years, and the subject has taken its place among the prominent topics of the academic platform. Based on all these developments, Turkey needs to address the effects of climate change, which is considered a global threat, in a multifaceted manner. In this context, the effect of climate change on selected sectors in Turkey is discussed in this study. The sectors discussed in the study are the energy and agriculture sectors, and the effects of climate change have been revealed with the econometric model. The effect of climate change on the agricultural sector in Turkey was analyzed with the Granger Causality Test. The study is based on the periods 1970-2017. The fact that the study deals with the subject on a sectoral basis and evaluates its effect on the agricultural sector based on product productivity constitutes the original aspect of the study. Based on the study results, it aims to develop climate policies for the sector and contribute to the literature.

MATERIALS AND METHOD

The model in which the relationship between the agricultural sector and climate change is examined is based on the periods 1970-2017. The precipitation and temperature data, which are among the climate data used in the study, are from the General Directorate of Meteorology (MGM), the carbon dioxide emission data and the share of the agricultural sector in GDP are from the World Bank, and the data on the productivity of grain products are annual average yields and are taken from the official website of the General Directorate of Nations (FAO). The variables used in the study and their abbreviations are given in Table 1.

Descriptive statistics of the variables used in this part of the study are given in Table 2.

The time path to the variables used in the study is given in Graph 1.

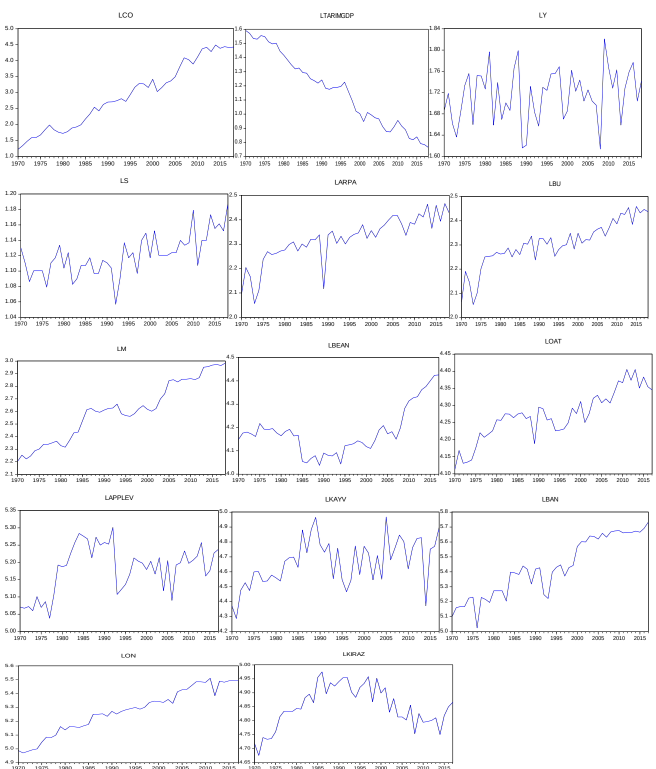
When we look at the series in general, it is seen that the series is not distributed around a mean. This gives preliminary information that the series is not stationary.

Table 1. Variables and Their Abbreviations Used in the Study.

Variables	Abbreviation	Source	Period
Share of agriculture sector in GDP (%)	lgdp	World Bank	1970-2017
Wheat productivity (kg/decare)	lbu	FAO	1970-2017
Corn productivity (kg/decare)	lm	FAO	1970-2017
Barley productivity (kg/decare)	larpa	FAO	1970-2017
Haricot Bean productivity (kg/decare)	lbean	FAO	1970-2017
Oat productivity (kg/decare)	loat	FAO	1970-2017
Apple productivity (kg/decare)	lapplev	FAO	1970-2017
Apricot productivity (kg/decare)	lkayv	FAO	1970-2017
Banana productivity (kg/decare)	lban	FAO	1970-2017
Cherry productivity (kg/decare)	lkir	FAO	1970-2017
Patato productivity (kg/decare)	lpat	FAO	1970-2017
Onion productivity (kg/decare)	lon	FAO	1970-2017
Precipitation average (mm/m^2)	ly	MGM	1970-2017
Temperature average (C^o)	ls	MGM	1970-2017
Carbon dioxide emissions (metric tons per capita)	lco	World Bank	1970-2017

Table 2. Descriptive Statistics for Used Variables.

	Ls	**Ly**	**lapple**	**larpa**	**Lban**	**lbean**	**lbu**	**lco**
Mean	1.119397	1.71579	5.18186	4.31982	5.43020	4.18173	4.30578	1.08362
Median	1.117271	1.72469	5.19764	4.33344	5.42304	4.16959	4.30907	1.07874
Maximum	1.178977	1.82086	5.30145	4.46774	5.73319	4.42571	4.45944	1.14891
Minimum	1.056905	1.61384	5.03842	4.08128	5.02444	4.03759	4.06822	1.02581
Std. Dev.	0.024814	0.04923	0.06923	0.09010	0.19790	0.10028	0.09074	0.03392
Skewness	0.171194	-0.20705	-0.40948	-0.89846	-0.09777	0.94671	-0.66211	-0.03851
Kurtosis	3.071112	2.45476	2.13765	3.70870	1.72919	3.26844	3.58994	1.88385
Jarque-Bera	0.244573	0.93752	2.82871	7.46232	3.30637	7.31412	4.20320	2.50346
Probability	0.884895	0.62578	0.24308	0.02397	0.19144	0.02581	0.12226	0.28601
Sum	53.73108	82.3580	248.729	207.352	260.65	200.723	206.677	52.0137
Sum Sq. Dev.	0.028940	0.11390	0.22525	0.38155	1.84064	0.47262	0.38699	0.05406
Observations	48	48	48	48	48	48	48	48
	Lgdp	Lkay	lkır	lm	loat	lon	Lpat	
Mean	1.17397	4.66581	4.85087	4.60019	4.27198	5.274935	5.339948	
Median	1.18863	4.68739	4.84699	4.61212	4.27475	5.285408	5.372730	
Maximum	1.59200	4.96742	4.97490	4.97397	4.40533	5.510813	5.526357	
Mnimum	0.78406	4.28720	4.67542	4.20680	4.11291	4.970547	5.087149	
Std. Dev	0.24955	0.15615	0.07348	0.22895	0.07176	0.161893	0.132887	
Skewness	0.10855	-0.18147	-0.25827	-0.0053	-0.22937	-0.26319	-0.51595	
Kurtosis	1.76279	2.53764	2.34562	1.92453	2.64958	2.063618	2.098618	
Jague Bera	3.15561	0.69101	1.39005	2.31349	0.66647	2.307761	3.754570	
Probability	0.20643	0.70786	0.49906	0.31451	0.71660	0.315410	0.153005	
Sum	56.3507	223.959	232.842	220.809	205.055	253.1969	256.3175	
Sum Sq. Dev.	2.92689	1.14606	0.25378	2.46370	0.24202	1.231838	0.829969	
Observations	48	48	48	48	48	48	48	



Graph 1. Time Path Chart of Variables.

RESULTS

In the study, first of all, unit root tests of the series should be done. In the study, first of all, unit root tests of the series should be done. In the case of non-stationary variables in time series analysis, spurious regression problems may occur. In such a case, the results obtained in the regression analysis reflect a real relationship. Although time path graphs are used to estimate the stationarity of the series, unit root testing is required to obtain precise results. The unit root test is to test the stationarity of the series (Saya, 2016: 90). In econometric models, the stationarity of the series is tested with unit root tests (Arslan and Yapraklı, 2008: 93). Dickey-Fuller (1979), Extended Dickey-Fuller (ADF) (1981), Phillips-Perron (PP) (1988) and KPSS (1992) tests are among the most applied tests for unit root testing. In this study, Extended Dickey-Fuller (ADF) and-Phillips-Perron (PP) (1988) test statistics were used to determine whether the series is stationary and the results are given in Table 3.

According to the unit root test results, the null hypothesis states that the series is not stationary; in other words, they contain a unit root, while the alternative hypothesis states that the series is stationary; in other words, it does not contain a unit root. When Table 3 is examined, it is concluded that all variables are stationary at the I (1) level.

Table 3. Unit Root Results of the Variables of the Agricultural Sector.

Variables	Tests	First Difference		Variables	Tests	First Difference	
		C	CT			C	CT
Lbu	ADF	-11,15906*** (0,0000)	-11,00798*** (0,0000)	Lkir	ADF	-11,67017*** (0,0000)	-11,95930*** (0,0000)
	PP	-4,770195*** (0,0004)	-4,917742*** (0,0014)		PP	-11,68164*** (0,0000)	-12,65009*** (0,0000)
larpa	ADF	-9,891997*** (0,0000)	-9,929144*** (0,0000)	Lpat	ADF	-7,323484*** (0,0000)	-7,348614*** (0,0000)
	PP	-36,20502*** (0,0001)	-34,89455*** (0,0000)		PP	-8,486751*** (0,0000)	-10,33221*** (0,0000)
lbean	ADF	-6,960280*** (0,0000)	-7,488151*** (0,0000)	lon	ADF	-10,99659*** (0,0000)	-11,05628** (0,0000)
	PP	-6,960280*** (0,0000)	-7,993187*** (0,0000)		PP	-11,68075*** (0,0000)	-13,94485*** (0,0000)
loat	ADF	-10,60426*** (0,0000)	-10,53678*** (0,0000)	Ly	ADF	-8,188777*** (0,0000)	-8,080649*** (0,0000)
	PP	-11,61289*** (0,0000)	-11,55970*** (0,0000)		PP	-36,83529*** (0,0000)	-36,26212*** (0,0000)
lm	ADF	-5,380911*** (0,0000)	-5,319282*** (0,0004)	Ls	ADF	-10,82194*** (0,0000)	-6,079365*** (0,0000)
	PP	-5,349457*** (0,0001)	-5,286143*** (0,0000)		PP	-20,58851*** (0,0001)	-28,92139*** (0,0000)
lapplev	ADF	-10,46170*** (0,0000)	-10,37966*** (0,0000)	Lgdp	ADF	-6,437132*** (0,0000)	-6,369895*** (0,0000)
	PP	-11,44615*** (0,0000)	-11,864747*** (0,0000)		PP	-7,007523*** (0,0000)	-6,965077*** (0,0000)
lkayv	ADF	-11,98251*** (0,0000)	-11,88298*** (0,0000)	Lco	ADF	-7,082138*** (0,0000)	-7,013468*** (0,0000)
	PP	-14,87007*** (0,0000)	-15,43087*** (0,0000)		PP	-7,082138*** (0,0000)	-7,013468*** (0,0000)
Lban	ADF	-7,899791*** (0,0000)	-7,803150*** (0,0000)				
	PP	-12,71982*** (0,0000)	-12,50881*** (0,0000)				

C: Fixed model. CT: Fixed and trending model. In the ADF test, the maximum number of delays was 12 and the optimum number of delays was determined according to the Schwarz Information Criteria. The numbers in parentheses are probability values. In the PP test, the long-term variance was obtained with the Barlett kernel estimator and the bandwidth (bandwidth) was determined by the Newey-West method. The critical values in the ADF and PP tests were -3,577 (1%), -2,925 (5%) and -2,601 (10%) for the fixed model; for the fixed and trend model, it is -4,161 (1%), -3.508 (5%) and -3.184 (10%). ***, ** and * indicate that the Ho hypothesis is rejected at the 1%, 5% and 10% significance levels.

***Granger Causality Test Results*:** The Granger Causality Test is used to test the existence and direction of the relationship between two variables. In this section, the relationship between climate change and crop productivity has been tested and the results are given in Table 4. In the Granger Causality test results in Table 4, the F calculation value was 9,33993 according to the causality test results from the average temperature to the level value of barley productivity. Considering the probability value belonging to the statistical value, the null hypothesis of "not Granger cause" was rejected and the alternative hypothesis was accepted at the 1% significance level. At the same time, the alternative hypothesis stating that the level value of the average temperature is the Granger cause of the first difference in dry bean and onion productivity was accepted at the 1% and 5% levels. It was also concluded that there was no significant relationship between the other agricultural products included in the analysis and the average temperature.

The alternative hypothesis, which accepts that the level value of the precipitation average, another of the climate variables in Table 4, is the Granger cause of the level value of barley productivity, was accepted at the 5% significance level. Again, in Table 4, the alternative hypothesis that the first

Table 4. **Granger Causality Test Results Between Agricultural Productivity and Average Temperature and Precipitation.**

Ho Hypothesis	Result	Delay	Observation	F Hesap değeri	Olasılık Değeri
ls(0), is not a Granger cause of larpa(0).	**DENIED**	**1**	**46**	**9,33993**	**0,0038**
ls(0), is not a Granger cause of Δlbu(0).	ACCEPTED	2	45	0,61642	0,5449
ls(0), is not a Granger cause of Δlm(0).	ACCEPTED	4	43	0.25364	0,9054
ls(0), is not a Granger cause of Δlapple(0).	ACCEPTED	1	45	0.27644	0,7599
ls(0), is not a Granger cause of Δlban(0).	ACCEPTED	4	43	1,53133	0.2152
ls(0), is not a Granger cause of Δlbean(0).	**DENIED**	**6**	**41**	**2.47061**	**0,0481**
ls(0), is not a Granger cause of lkay(0).	ACCEPTED	3	44	0,50719	0,6797
ls(0), is not a Granger cause of Δlkir(0).	ACCEPTED	1	46	0,00862	0,9265
ls(0), is not a Granger cause of Δloat(0).	ACCEPTED	3	44	2,20905	0,1197
ls(0), is not a Granger cause of Δlon(0).	**DENIED**	**2**	**45**	**6,07539**	**0,0050**
ls(0), is not a Granger cause of Δlpat (0).	ACCEPTED	1	46	0,01228	0,9123
ly(0), is not a Granger cause of larpa(0).	**DENIED**	**3**	**45**	**3,32185**	**0,0298**
ly(0), is not a Granger cause of Δlbu(0).	**DENIED**	**2**	**46**	**4,40894**	**0,0417**
ly(0), is not a Granger cause of Δlm(0).	ACCEPTED	1	46	0,00011	0,9918
ly(0), is not a Granger cause of Δlapple(0).	ACCEPTED	4	43	0.62725	0,6463
ly(0), is not a Granger cause of Δlban(0).	**DENIED**	**3**	**44**	**2,64404**	**0.0635**
ly(0), is not a Granger cause of Δlbean(0).	**DENIED**	**4**	**43**	**2.17137**	**0,0832**
ly(0), is not a Granger cause of lkay(0).	ACCEPTED	1	47	0,51742	0,4757
ly(0), is not a Granger cause of Δlkir(0).	**DENIED**	**1**	**46**	**3,14645**	**0,0832**
ly(0), is not a Granger cause of Δloat(0).	**DENIED**	**1**	**46**	**4,12419**	**0,0485**
ly(0), is not a Granger cause of Δlon(0).	ACCEPTED	5	42	0,91888	0,4818
ly(0), is not a Granger cause of Δlpat (0).	ACCEPTED	1	46	0,33852	0,5637

difference in the wheat productivity of the average precipitation value is the Granger cause was accepted at the 5% significance level. In addition, the alternative hypothesis that the level value of the precipitation average is the Granger cause of the first difference of banana productivity, the first difference of dry bean productivity and the first difference of cherry productivity were accepted at a 10% significance level. Apart from this, it was concluded that there is no significant relationship between the productivity of agricultural products and the average precipitation. When the average temperature and average precipitation values are examined, it is seen in the results obtained that the average precipitation is more decisive in the productivity of agricultural products. In other words, it was concluded that the average precipitation affects the product productivity more than the average temperature in most of the selected agricultural products.

The significance levels of the coefficients in the Granger causality equations are given in Table 5 for the mean temperature.

When the coefficients of the Granger causality equations in Table 5 were statistically evaluated, it was concluded that the trend coefficient was statistically significant at the 1% level in the causality equation established between the average temperature level value and the level value of barley productivity. In the causality equation established at the level value of the average temperature and the first difference level of wheat productivity, the coefficients of the delays of the first difference of wheat productivity were statistically significant at the 1% level.

In the Granger causality equation established between the level value of another average temperature variable in Table 5 and the first difference of apple productivity, it was concluded that the coefficients of the first delay of apple productivity and the first delay of the temperature average were statistically significant at the 1% and 5% levels.

Another result obtained in the study determined that the first delay coefficient of banana productivity was statistically significant at the 1% level, according to the Granger equation established between the level value of the temperature average and the banana productivity. In the Granger causality equation established between the level value of the temperature average and cherry productivity, it is concluded that the trend variable coefficient is statistically significant at the 5% level and the cherry productivity at the 1% level.

In the causality equation established between the level value of the temperature average and oat productivity, it was determined that the first delay of the oat productivity and the first delay of the temperature average were statistically significant at the level of 5% and 10%, respectively. Finally, in the Granger equation established between the average temperature and onion productivity, it is seen that the

coefficient of the first delay of dry onion productivity is statistically significant at the 1% level.

Table 5. Statistical Significance of Granger Causality Equation Coefficients of Agricultural Product Productivity and Average Temperature.

-	Variable	Coefficient	Standard Error	T Statistic	Probability Value
Δlarpa-ls	c	3,856044	0,934991	4,124151	0,0002
	@trend	0,004743	0,001225	3,871416	0,0004
	ls(-1)	0,320017	0,380124	0,841874	0,3724
	larpa(-1)	0,134380	0,149050	0,901576	0,4046
	c	-0.123476	0.563969	-0.218941	0.8279
Δlbu-ls	Δbu(-1)	-0.453346	0.156025	-2.905605	0.0061
	Δbu(-2)	-0.204874	0.139794	-1.465543	0.1510
	ls(-1)	0.422105	0.330477	1.277259	0.2093
	ls(-2)	0.299086	0.324969	0.920353	0.3632
	@trend	-0.000258	0.000785	-0.328626	0.7442
	c	-0.187840	0.353215	-0.531801	0.5984
Δlm-ls	Δlm(-1)	0.194672	0.163174	1.193038	0.2414
	Δlm(-2)	-0.112072	0.166131	-0.674602	0.5046
	Δlm(-3)	0.012818	0.163418	0.078436	0.9380
	Δlm(-4)	-0.139921	0.157145	-0.890394	0.3797
	ls(-1)	-0.060230	0.276950	-0.217477	0.8292
	ls(-2)	-0.033823	0.281260	-0.120255	0.9050
	ls(-3)	0.111175	0.274578	0.404893	0.6882
	ls(-4)	0.566597	0.292625	1.936252	0.0614
Δlapple-ls					
	c	-0.988729	0.584358	-1.691993	0.0982
	Δlapple(-1)	-0.440510	0.133395	-3.302286	0.0020
	ls(-1)	0.857854	0.391108	2.193395	0.0340
	@trend	-0.001400	0.000868	-1.613295	0.1144
Δlban-ls					
	c	-1.208627	1.398396	-0.864296	0.3939
	ls(-4)	-0.391535	0.639701	-0.612060	0.5448
	Δlban(-4)	0.108968	0.179437	0.607278	0.5480
	Δlban(-3)	0.103442	0.200806	0.515133	0.6100
	Δlban(-2)	-0.364178	0.201352	-1.808664	0.0799
	Δlban(-1)	-0.563331	0.176713	-3.187826	0.0032
	ls(-3)	-0.839767	0.647134	-1.297671	0.2037
	ls(-2)	-0.184266	0.647897	-0.284407	0.7779
	ls(-1)	1.018521	0.640603	1.589941	0.1217
	@trend	-0.001649	0.001784	-0.924544	0.3621
Δlbean-ls	c	0.633917	0.954087	0.664423	0.5133
	@trend	0.001931	0.001130	1.709425	0.1014
	Δlbean(-1)	-0.181971	0.203164	-0.895686	0.3801
	Δlbean(-2)	-0.095865	0.191422	-0.500807	0.6215
	Δlbean(-3)	-0.058887	0.186947	-0.314993	0.7557
	Δlbean(4)	-0.060125	0.228035	-0.263665	0.7945
	Δlbean(-5)	0.004717	0.214597	0.021983	0.9827
	Δlbean(-6)	0.275281	0.265535	1.036705	0.3111
	ls(-1)	0.475123	0.365775	1.298947	0.2074
	ls(-2)	0.067571	0.352140	0.191886	0.8496
	ls(-3)	-0.058302	0.354775	-0.164337	0.8710

-	Variable	Coefficient	Standard Error	T Statistic	Probability Value
	ls(-4)	-0.049387	0.391278	-0.126221	0.9007
	ls(-5)	0.068600	0.402236	0.170548	0.8661
	ls(-6)	-0.729473	0.369035	-1.976702	0.0607
Δlkay-ls	c	3.430353	3.442966	0.996337	0.3257
	lkay(-1)	0.074672	0.167301	0.446334	0.6580
	lkay(-2)	0.216039	0.162809	1.326949	0.1929
	lkay(-3)	0.082407	0.169598	0.485895	0.6300
	ls(-1)	-0.676118	1.135075	-0.595659	0.5551
	ls(-2)	0.353728	1.147634	0.308224	0.7597
	ls(-3)	1.014665	1.160664	0.874211	0.3878
	@trend	0.003056	0.004026	0.758958	0.4528
Δlkir-ls					
	c	-0.551821	0.470995	-1.171608	0.2481
	@trend	-0.001335	0.000702	-1.902326	0.0642
	Δlkır(-1)	-0.519335	0.127198	-4.082872	0.0002
	ls(-1)	0.472271	0.315159	1.498516	0.1417
Δloat-ls					
	c	-0.364222	0.534468	-0.681465	0.5001
	Δloat(-1)	-0.422761	0.172706	-2.447864	0.0195
	Δloat(-2)	-0.164233	0.183628	-0.894377	0.3772
	Δloat(-3)	-0.059908	0.163634	-0.366108	0.7165
	ls(-1)	0.472258	0.278203	1.697533	0.0985
	ls(-2)	0.202709	0.279547	0.725135	0.4732
	ls(-3)	-0.008785	0.266047	-0.033019	0.9738
	@trend	-0.000791	0.000720	-1.097803	0.2798
Δlon-ls					
	c	0.154460	0.415872	0.371414	0.7124
	@trend	-0.000376	0.000589	-0.637452	0.5277
	Δlon(-1)	-0.508480	0.145283	-3.499929	0.0012
	Δlon(-2)	-0.161727	0.142024	-1.138725	0.2619
	ls(-1)	0.415119	0.232662	1.784215	0.0824
	ls(-2)	-0.619297	0.232904	-2.659020	0.0114
Δlpat-ls	c	-0.231445	0.287531	-0.804939	0.4255
	Δlpat(-1)	-0.115144	0.153019	-0.752482	0.4561
	ls(-1)	0.195322	0.192238	1.016042	0.3156
	@trend	-0.000506	0.000429	-1.179617	0.2450

Table 6. Statistical Significances of Coefficients in Granger Causality Equations of Agricultural Product Productivity and Precipitation Average.

	Variable	Coefficient	Standard Error	T Statistic	Probability Value
	ly	0,453077	0,179774	2,520267	0,0162
	c	0,025879	0,624183	0,04146	0,9672
larpa-ly	larpa(-1)	0,229343	0,17101	1,341112	0,1881
	larpa(-2)	0,427332	0,176728	2,418024	0,0206
	larpa(-3)	0,122394	0,167227	0,731899	0,4688
	ly(-1)	0,053385	0,187073	0,285371	0,777
	ly(-2)	-0,094496	0,172863	-0,546652	0,5879
	ly(-3)	0,135047	0,174288	0,77485	0,4434
	ly	0,245176	0,125151	1,959036	0,0569
Δlbu-ly	c	-0,407852	0,304017	-1,341544	0,1871
	Δlbu(-1)	-0,494676	0,133995	-3,691734	0,0006

	Variable	Coefficient	Standard Error	T Statistic	Probability Value
	ly(-1)	0,002025	0,119355	0,016966	0,9865
	@trend	-0,000282	0,000457	-0,616553	0,5409
	ly	-0,104096	0,108271	-0,961445	0,342
	c	0,185677	0,266233	0,697422	0,4895
Δlm-ly	Δm(-1)	0,209996	0,152061	1,381002	0,1748
	ly(-1)	0,00166	0,109711	0,015127	0,988
	@trend	8.64E-05	0,000413	0,209178	0,8353
	ly	0,261582	0,149839	1,745761	0,0904
	c	-2,688059	0,72049	-3,730876	0,0007
	Δlapple(-1)	-0,55599	0,156073	-3,562382	0,0012
	Δlapple(-2)	-0,214333	0,160918	-1,331941	0,1923
	Δlapple(-3)	-0,457359	0,160659	-2,84677	0,0076
Δlapple-ly	Δlapple(-4)	-0,125492	0,169972	-0,738309	0,4657
	ly(-1)	0,38692	0,150806	2,56567	0,0152
	ly(-2)	0,142449	0,162471	0,876767	0,3871
	ly(-3)	0,347879	0,14746	2,359147	0,0246
	ly(-4)	0,452496	0,157979	2,864286	0,0073
	@trend	-0,0014	0,000621	-2,256807	0,031
	ly	-0,027307	0,246854	-0,110619	0,9126
	c	-0,493644	0,869593	-0,567672	0,5739
	Δlban(-1)	-0,420126	0,174488	-2,407763	0,0215
	Δlban(-2)	-0,336377	0,171588	-1,960372	0,058
Δlban-ly	Δlban(-3)	-0,017146	0,173582	-0,098777	0,9219
	ly(-1)	-0,091756	0,232433	-0,394765	0,6954
	ly(-2)	-0,035626	0,236512	-0,150629	0,8811
	ly(-3)	0,458513	0,22644	2,024876	0,0506
	@trend	-0,000187	0,000883	-0,211544	0,8337
	ly	0,094252	0,12567	0,750001	0,4587
	c	0,274426	0,54093	0,507323	0,6154
	Δlbean(-1)	-0,237589	0,184367	-1,288676	0,2068
	Δlbean(-2)	-0,084978	0,188996	-0,449628	0,656
	Δlbean(-3)	-0,050813	0,183055	-0,277582	0,7831
Δlbean-ly	Δlbean(-4)	-0,211695	0,178816	-1,183871	0,2452
	ly(-1)	-5.77E-05	0,125096	-0,000461	0,9996
	ly(-2)	-0,15625	0,125527	-1,24475	0,2223
	ly(-3)	-0,000532	0,118874	-0,004477	0,9965
	ly(-4)	-0,111623	0,112796	-0,9896	0,3298
	@trend	0,001278	0,000525	2,432735	0,0208
	ly	-0,27288	0,425858	-0,640778	0,5251
Δlkay-ly	c	3,750961	1,393877	2,691027	0,0102
	lkay(-1)	0,220539	0,152453	1,4466	0,1554
	ly(-1)	0,156539	0,420285	0,37246	0,7114
	@trend	0,003873	0,001776	2,180661	0,0349
	ly	0,037458	0,124254	0,301464	0,7646
	c	-0,204825	0,295187	-0,693881	0,4917
Δlkir-ly	Δlkır(-1)	-0,530448	0,135009	-3,928975	0,0003
	ly(-1)	0,09637	0,122464	0,786927	0,4358
	@trend	-0,000786	0,000462	-1,700346	0,0966
	ly	0,104928	0,096366	1,088849	0,2826
	c	-0,028767	0,229689	-0,125241	0,9009
Δloat-ly	Δloat(-1)	-0,467811	0,14223	-3,289116	0,0021
	ly(-1)	-0,081307	0,09154	-0,888214	0,3796

	Variable	Coefficient	Standard Error	T Statistic	Probability Value
	@trend	-0,000222	0,000352	-0,629646	0,5324
	ly	-0,084062	0,115626	-0,727017	0,473
	c	0,492204	0,572852	0,859217	0,3973
	Δlon(-1)	-0,566817	0,187974	-3,015404	0,0053
	Δlon(-2)	-0,196347	0,213584	-0,919293	0,3655
	Δlon(-3)	-0,148748	0,213535	-0,696598	0,4916
	Δlon(-4)	-0,188446	0,212672	-0,88609	0,3829
Δlon-ly	Δlon(-5)	-0,241194	0,208258	-1,158152	0,2563
	ly(-1)	-0,060561	0,115869	-0,522667	0,6052
	ly(-2)	-0,088523	0,114729	-0,771586	0,4466
	ly(-3)	-0,077954	0,113882	-0,684509	0,4991
	ly(-4)	0,099231	0,109481	0,906376	0,3722
	ly(-5)	-0,049915	0,110903	-0,450074	0,656
	@trend	-0,000602	0,000493	-1,220469	0,2321
	ly	0,04472	0,073195	0,610979	0,5446
	c	-0,111848	0,178952	-0,625018	0,5354
Δlpat-ly	Δlpat(-1)	-0,127022	0,155385	-0,817467	0,4184
	ly(-1)	0,030608	0,073121	0,418596	0,6777
	@trend	-0,000281	0,00028	-1,004399	0,3211

Table 7. Investigation of Stability and Residues of VAR Models Established Between Average Temperature and Productivity of Agricultural Products.

	Stability Test	Multivariate Normality	Portmanteau Autocorrelation	Varying variance
larpa(0)-ls(0)				
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	**-**	47,99725		
Jaque-Bera Probability	**-**	0,0000		
Q(1) Account Value of the Series	**-**		0,872400	
Q(1) Probability Value of the Series	**-**		0,9235	
Changing Variance Chi-Square	**-**			21,730662
Changing Variance Chi-Square Probability Value	**-**			0,2642
Δlbu(0)-ls(0)				
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	**-**	5,058398		
Jaque-Bera Probability	**-**	0,2814		
Q(1) Account Value of the Series	**-**		3,885724	
Q(1) Probability Value of the Series	**-**		0,3992	
Changing Variance Chi-Square	**-**			31,58051
Changing Variance Chi-Square Probability Value	**-**			0,3873
Δlm(0)-ls(0)				
Stability Test Result				
Jaque-Bera (COMMON)	**STABLE**	6,441943		
Jaque-Bera Probability	**-**	0,1685		
Q(1) Account Value of the Series	**-**		3,893151	
Q(1) Probability Value of the Series	**-**		0,4207	
Changing Variance Chi-Square	**-**			62,25416
Changing Variance Chi-Square Probability Value	**-**			0,2060
Δlapple(0)-ls(0)				
Stability Test Result	**STABLE**			

	Stability Test	**Multivariate Normality**	**Portmanteau Autocorrelation**	**Varying variance**
Jaque-Bera (COMMON)	-	6,284627		
Jaque-Bera Probability	-	0,1789		
Q(1) Account Value of the Series	-		5,2788587	
Q(1) Probability Value of the Series	-		0,2599	
Changing Variance Chi-Square	-			10,21345
Changing Variance Chi-Square Probability Value	-			0,7354
Δlban(0)-ls(0)				
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	7,189822		
Jaque-Bera Probability	-	0,1262		
Q(1) Account Value of the Series	-		2,786051	
Q(1) Probability Value of the Series	-		0,5942	
Changing Variance Chi-Square	-			58,84393
Changing Variance Chi-Square Probability Value	-			0,3027
Δlbean(0)-ls(0)				
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	6,438473		
Jaque-Bera Probability	-	0,1687		
Q(1) Account Value of the Series	-		13,29943	
Q(1) Probability Value of the Series	-		0,0099	
Changing Variance Chi-Square	-			77,79489
Changing Variance Chi-Square Probability Value	-			0,4852
Δlkay(0)-ls(0)				
	Stability Test	Multivariate Normality	Portmanteau Autocorrelation	Varying variance
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	3,180597		
Jaque-Bera Probability	-	0,5281		
Q(1) Account Value of the Series	-		3,023727	
Q(1) Probability Value of the Series	-		0,5539	
Changing Variance Chi-Square	-			47,53420
Changing Variance Chi-Square Probability Value	-			0,2574
Δlkir(0)-ls(0)				
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	5,975650		
Jaque-Bera Probability	-	0,2010		
Q(1) Account Value of the Series	-		4,189877	
Q(1) Probability Value of the Series	-		0,3809	
Changing Variance Chi-Square	-			23,61268
Changing Variance Chi-Square Probability Value	-			0,1681
Δloat(0)-ls(0)				
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	0,992669		
Jaque-Bera Probability	-	0,9109		
Q(1) Account Value of the Series	-		5,217795	
Q(1) Probability Value of the Series	-		0,2657	

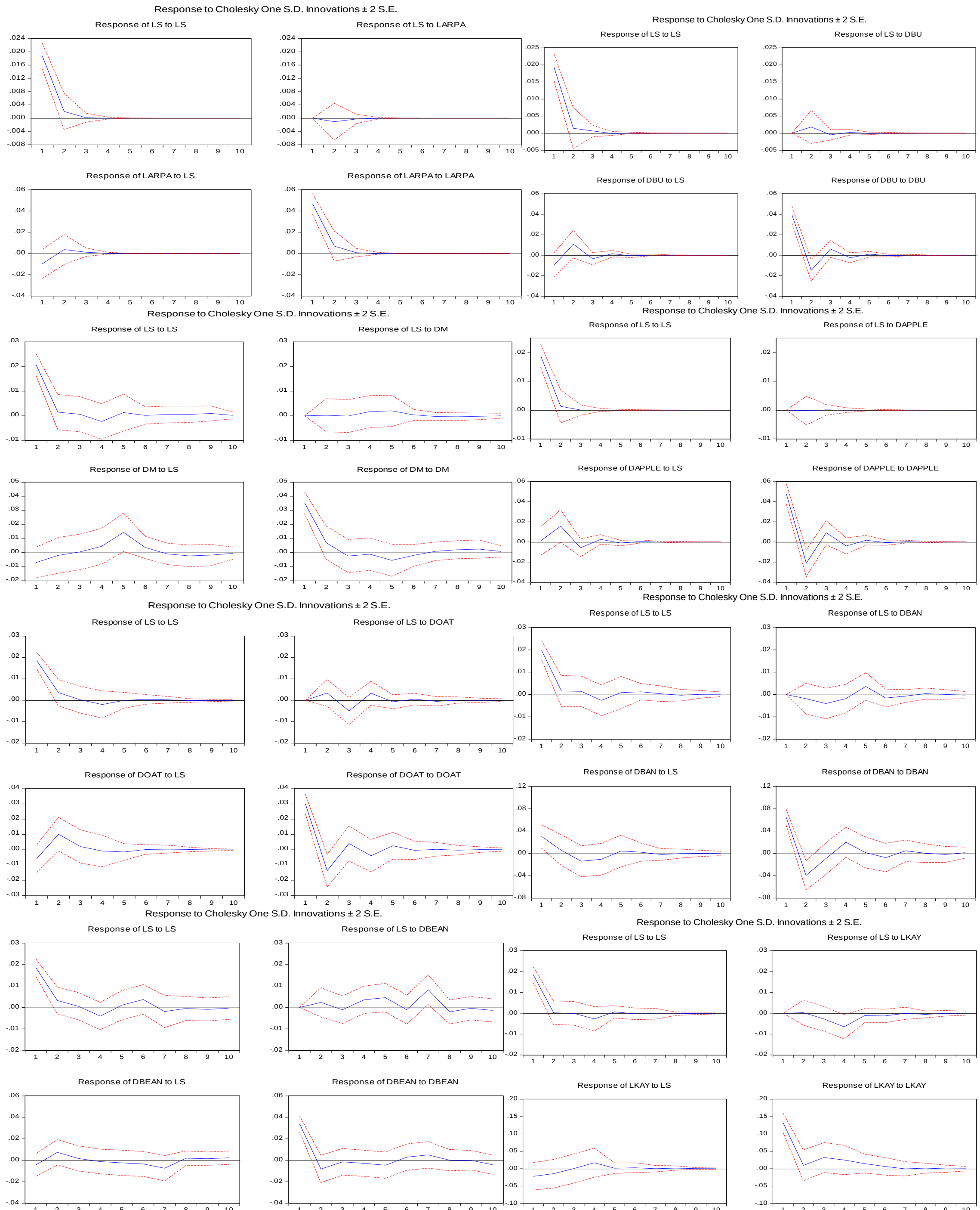
	Stability Test	Multivariate Normality	Portmanteau Autocorrelation	Varying variance
Changing Variance Chi-Square	-			49,57633
Changing Variance Chi-Square Probability Value	-			0,1967
Δlon(0)-ls(0)				
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	6,069211		
Jaque-Bera Probability	-	0,1940		
Q(1) Account Value of the Series	-		2,897317	
Q(1) Probability Value of the Series	-		0,5752	
Changing Variance Chi-Square	-			32,42643
Changing Variance Chi-Square Probability Value	-			0,3480
Δlpat(0)-ls(0)				
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	4,764727		
Jaque-Bera Probability	-	0,3123		
Q(1) Account Value of the Series	-		5,298287	
Q(1) Probability Value of the Series	-		0,2580	
Changing Variance Chi-Square	-			11,41213
Changing Variance Chi-Square Probability Value	-			0,8761

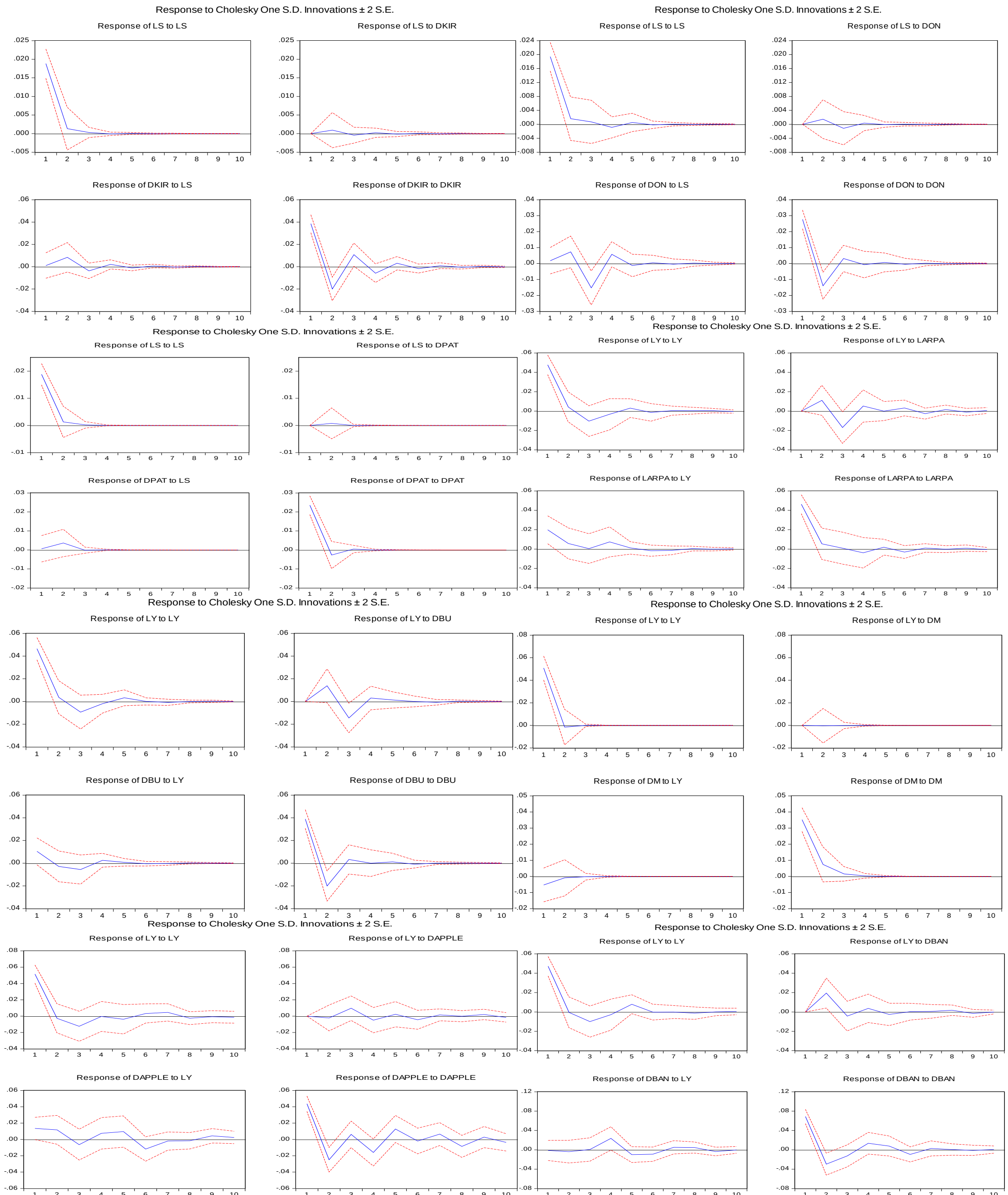
Table 8. Investigation of Stability and Residue of VAR Models Established Between Average Precipitation and Productivity of Agricultural Products.

	Stability Test	Multivariate Normality	Portmanteau Autocorrelation	Varying variance
	larpa(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	57,22098		
Jaque-Bera Probability	-	0,0000		
Q(1) Account Value of the Series	-		5,258263	
Q(1) Probability Value of the Series	-		0,2618	
Changing Variance Chi-Square	-			59,39550
Changing Variance Chi-Square Probability Value	-			0,395
	Δlbu(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	3,489912		
Jaque-Bera Probability	-	0,4794		
Q(1) Account Value of the Series	-		3,036267	
Q(1) Probability Value of the Series	-		0,5321	
Changing Variance Chi-Square	-			17,51007
Changing Variance Chi-Square Probability Value	-			0,4883
	Δlm(0)-ly(0)			
Stability Test Result				
Jaque-Bera (COMMON)	**STABLE**	3,046553		
Jaque-Bera Probability	-	0,5501		
Q(1) Account Value of the Series	-		2,435086	
Q(1) Probability Value of the Series	-		0,6563	
Changing Variance Chi-Square	-			16,34704
Changing Variance Chi-Square Probability Value	-			0,5683
	Δlapple(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	2,913993		
Jaque-Bera Probability	-	0,5723		
Q(1) Account Value of the Series	-		2,413350	

	Stability Test	Multivariate Normality	Portmanteau Autocorrelation	Varying variance
Q(1) Probability Value of the Series	-		0,6602	
Changing Variance Chi-Square	-			58,76288
Changing Variance Chi-Square Probability Value	-			0,3053
	Δlban(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	1,352139		
Jaque-Bera Probability	-	0,8525		
Q(1) Account Value of the Series	-		4,411802	
Q(1) Probability Value of the Series	-		0,3531	
Changing Variance Chi-Square	-			58,84393
Changing Variance Chi-Square Probability Value	-			0,3027
	Δlbean(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	4,395984		
Jaque-Bera Probability	-	0,3551		
Q(1) Account Value of the Series	-		4,564068	
Q(1) Probability Value of the Series	-		0,3350	
Changing Variance Chi-Square	-			61,86375
Changing Variance Chi-Square Probability Value	-			0,2159
	lkay(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	2,652563		
Jaque-Bera Probability	-	0,6175		
Q(1) Account Value of the Series	--		4,399930	
Q(1) Probability Value of the Series	-		0,3546	
Changing Variance Chi-Square	-			10,38300
Changing Variance Chi-Square Probability Value	-			0,9187
	Δlkir(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	2,790243		
Jaque-Bera Probability	-	0,5935		
Q(1) Account Value of the Series	-		3,752674	
Q(1) Probability Value of the Series	-		0,4405	
Changing Variance Chi-Square	-			21,15035
Changing Variance Chi-Square Probability Value	-			0,2719
	Δloat(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	0,824061		
Jaque-Bera Probability	-	0,9352		
Q(1) Account Value of the Series	-		4,080041	
Q(1) Probability Value of the Series	-		0,3953	
Changing Variance Chi-Square	-			19,53638
Changing Variance Chi-Square Probability Value	-			0,3595
	Δlon(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	6,934969		
Jaque-Bera Probability	-	0,1394		
Q(1) Account Value of the Series	-		3,328247	
Q(1) Probability Value of the Series	-		0,5045	
Changing Variance Chi-Square	-			69,02187
Changing Variance Chi-Square Probability Value	-			0,3756
Stability Test Result	-			
	Δlpat(0)-ly(0)			
Stability Test Result	**STABLE**			
Jaque-Bera (COMMON)	-	2,688410		
Jaque-Bera Probability	-	0,6112		
Q(1) Account Value of the Series	-		7,666688	
Q(1) Probability Value of the Series	-		0,1046	

	Stability Test	Multivariate Normality	Portmanteau Autocorrelation	Varying variance
Changing Variance Chi-Square	-			17,94516
Changing Variance Chi-Square Probability Value	-			0,4593




Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of LS to LS
Response of LS to DKIR
Response of DKIR to LS
Response of DKIR to DKIR
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Response to Cholesky One S.D. Innovations ± 2 S.E.
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Response to Cholesky One S.D. Innovations ± 2 S.E.
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Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of LY to LY
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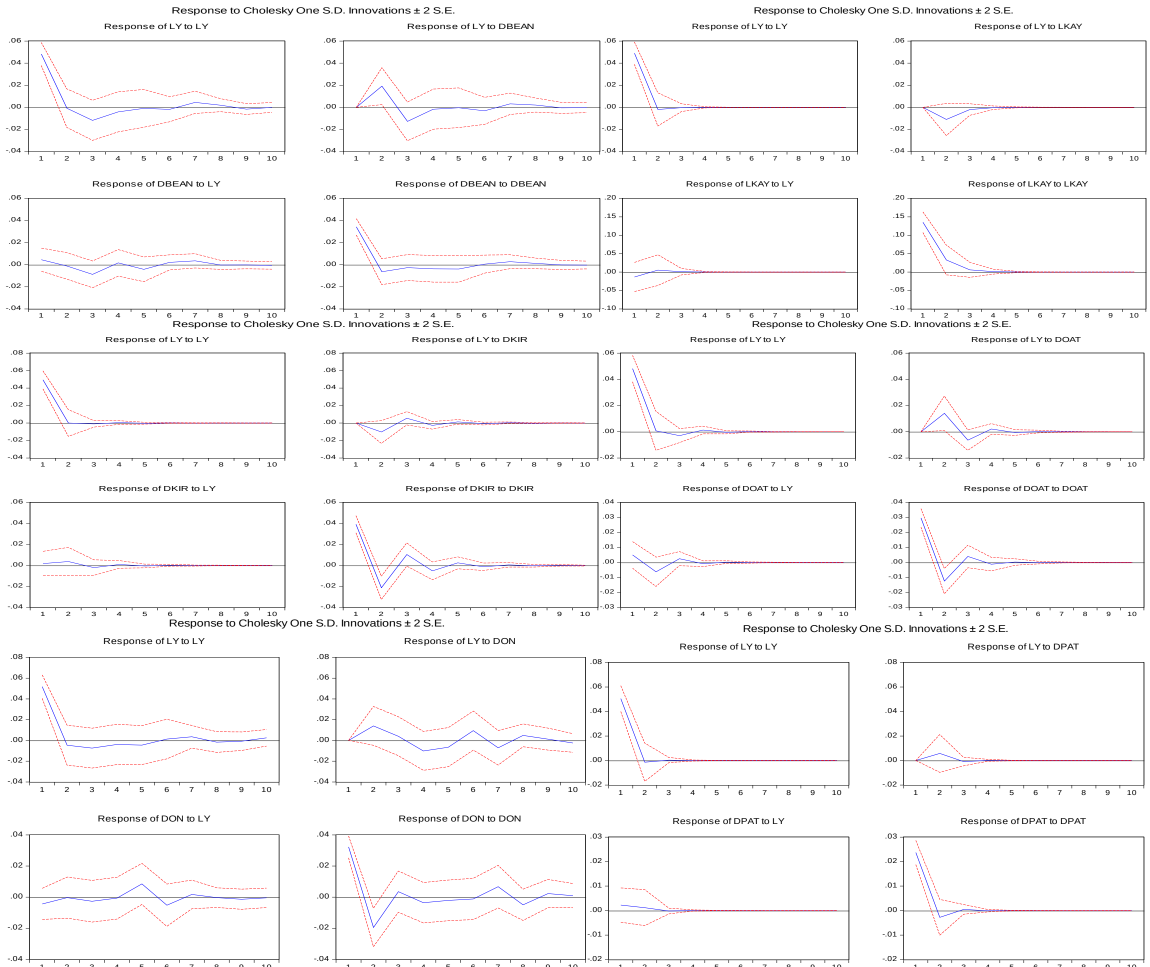

Graph 2.

The statistical significance of the coefficients in the Granger causality equations of agricultural crop productivity and precipitation average is given in Table 6.

According to the results in Table 6, the value of the barley productivity at the second delay was statistically significant at the level of 5%, according to the Granger causality equation established with the value of the precipitation average at the level and the value of the barley productivity at the level. In the equation established between the mean precipitation and the difference value of wheat productivity, it was concluded that the first difference of wheat productivity was significant at 1%. In the equation established between the mean precipitation and the difference value of wheat productivity, it was concluded that the first difference of wheat productivity was significant at 1%. Considering the Granger causality equation coefficients established between the level value of the precipitation average and apple productivity, the first and third delays of apple productivity were statistically significant at the 1% level. In comparison, the coefficient of the first and fourth delays of the precipitation average was statistically significant at the 1% level. The level value of the average precipitation, the first and second delays of the banana productivity, and the trend value coefficient were found to be statistically significant. In the equations of apricot productivity and dry bean productivity, only the coefficient of the trend value was found to be statistically significant. According to another result in Table 6, while the level value of the precipitation average and the first delay of cherry productivity and the first delay of onion productivity were statistically significant, there was no statistical significance in the coefficients of the variables that are not mentioned. Estimating the VAR model by determining the lag length based on information criteria does not mean the best model is estimated. Among the criteria to be found in order to create a good VAR model, it is necessary to provide the stability condition in the creation of the model, the absence of correlation in the series, the validity of the constant variance condition and the assumption of normality (Mert and Çağlar,2019:224). This section will be checked whether the

estimated VAR models meet the necessary conditions to be a suitable model.

The results for the VAR models established between the average temperature and the productivity of grain products are given in Table 7. In all stability tests, it was concluded that the VAR models established for the level value of the temperature average and their efficiency were stable. In the Jargue Bera test, which was used to test the normality of the multi-variability of residues belonging to the VAR models, the null hypothesis was accepted that all residues except barley productivity were normally distributed, and the alternative hypothesis was accepted, showing that there was no normal distribution in barley productivity. In the hypotheses of the Portmanteu autocorrelation test in Table 7, the null hypothesis that the residues are not auto-correlated in the VAR models established between the average temperature level value and the productivity of agricultural products was accepted, while the alternative hypothesis was rejected.

The results of the assumption that it does not contain varying variance, another criterion based on selecting the appropriate VAR model, are also given in Table 7. According to Table 7, in the VAR model established between the level value of the average temperature and the productivity of agricultural products, the null hypothesis that the residuals do not contain varying variance was accepted.

The analysis of the stability and residuals of the VAR models established between the average precipitation and the productivity of grain products is given in Table 7. All stability tests concluded that the level value of the precipitation average and the VAR models established for their efficiency were stable. In the Jargue-Bera test, which is used to test the normality of the multi-variability of residues belonging to the VAR models, the null hypothesis that all residues except barley productivity are normally distributed was accepted, and the alternative hypothesis was accepted, showing that there was no normal distribution in barley productivity. In the hypotheses of the Portmanteu autocorrelation test in Table 7, the null hypothesis that the residues are not auto-correlated in the VAR models established between the mean precipitation level value and the productivity of agricultural products was accepted, while the alternative hypothesis was rejected. Again, according to Table 7, the null hypothesis that the residuals do not contain varying variance in the VAR model established between the level value of the precipitation average and the productivity of agricultural products was accepted.

***Impulse-Response Functions*:** In this section, the effect of climate change indicators on selected grain products is aimed to be revealed by impulse-response functions, one of the econometric analysis methods. Interpretation of VAR model coefficients alone is not considered an accurate method. In order to overcome this deficiency, the graphs of impulse-response functions are used, and the effects of instantaneous shocks that may occur in variables can be revealed with this analysis. The red dashed lines (+,- 2) in the impulse response graphs show the confidence intervals according to the standard error Choleksy method, and the blue line in the graphs shows the response of the variable to the standard deviation shock. For the graphs in this function to be meaningful, the confidence interval must either be in the positive or negative regions (Saya, 2016: 110).

***Impulse Response Functions on Average Temperature and Agricultural Product Productivity*:** The impulse response functions of the production efficiencies and the average temperature are given in Graph 2.

It is seen that the effect of a standard shock from barley productivity affects barley productivity negatively and its effect is lost in about 1.5 years. It is seen that the effect of the shock from the average temperature, on the other hand, affects the average temperature negatively by decreasing for a period of time and loses its effect after a period. It is observed that the effect of a shock originating from the average temperature loses its effect on wheat productivity after a period. It is seen that the effect of the shock occurring in the average temperature has decreased and lost its effect within a period. It is seen that a shock to the average temperature does not have a significant effect on maize productivity. It is seen that a shock to the average temperature does not have a significant effect on apple productivity. It is seen that a shock to the average temperature does not have a significant effect on banana productivity. It is seen that a shock to the average temperature does not have a significant effect on dry bean productivity. It is seen that a shock to the average temperature does not have a significant effect on apricot productivity. It is seen that a shock to the average temperature does not have a significant effect on cherry productivity. It is seen that a shock to the average temperature does not have a significant effect on oat productivity. It is seen that a shock to the average temperature does not have a significant effect on onion productivity. It is seen that a shock to the average temperature does not have a significant effect on potato productivity.

It is seen that the effect of a standard shock from barley productivity affects barley productivity negatively and its effect is lost in about 1.5 years. It is seen that the effect of the shock from the precipitation average, on the other hand, affects the precipitation average negatively by decreasing for a period of time and loses its effect after a period. It is seen that the shock to the precipitation average does not significantly affect barley productivity. It has been determined that the shock occurring in the precipitation average does not significantly affect wheat productivity. It is observed that the effect of a shock on wheat productivity diminishes within a year and loses its effect. It is seen that the effect of a standard shock from maize productivity negatively affects maize productivity and its effect is lost in about 1.5 years. It is seen that the effect of the shock from the precipitation average, on the other hand, affects the precipitation average negatively by decreasing for a period of

time and loses its effect after a period. It is seen that the shock to the precipitation average does not significantly affect the maize productivity. It was concluded that there is no significant relationship between the apricot, dry bean and cherry productivity and the average precipitation. It was concluded that there was no significant relationship between oat, potato and onion yields and average precipitation.

***Variance Decomposition*:** While impulse response functions provide information about the direction of the series against shocks, variance decomposition reveals how the total change is relatively distributed over the periods (Mert and Çağlar, 2019:220). This section discusses the effect of shocks between climate variables on agricultural product productivity with the variance distribution. According to the results of the Decomposition of Variance between Average Temperature and Product Efficiency:

When the variance decomposition results between barley productivity and temperature are examined, it is seen that 100% of the shocks in barley productivity in the first year are caused by itself. In the second and tenth periods, it is seen that 98.88% of the shocks in barley productivity are caused by its past shocks and 1.11% by the shocks caused by the temperature variable.

When the variance decomposition results between wheat productivity and temperature are examined, it is seen that 100% of the shocks in wheat productivity in the first year are caused by itself. In the second year, 97.43% of the shocks in wheat productivity come from their past shocks and 2.03% from the temperature variable, and in the third year, 97.43% of the shocks in wheat productivity are from their past shocks and 2.56% appears to be due to occurred shocks. In the fourth and tenth periods, 97.25% of the shocks in wheat productivity are caused by its past shocks and 2.74% by the shocks caused by the temperature variable. The relationship between the two variables disappears within three years.

When the variance decomposition results between maize productivity and temperature are examined, it is seen that 100% of the shocks in maize productivity in the first year are caused by itself. 99.96% of the shocks in maize productivity in the second year are due to their past shocks and 0.03% to the temperature variable. 99.96% of the shocks in maize productivity in the third year are caused by their own past shocks and 0.031% by shocks. In the fourth year, 98.74% of the shocks in maize productivity were caused by its own past shocks and 1.254% by the temperature variable. In the fifth and tenth periods, it is seen that 88.53% of the shocks in maize productivity are caused by their past shocks and 11.46% are caused by the temperature variable.

When the variance decomposition results between apple productivity and temperature are examined, it is seen that 100% of the shocks in apple productivity in the first year are caused by itself. 91.04% of the shocks in apple productivity in the second year are from their past shocks and 8.95% from the temperature variable; 90.57% of the third and tenth year apple productivity are from their past shocks and 9.42% appears to be due to occurred shocks. It is seen that the relationship between the two variables loses its effect after two years.

When the variance decomposition results between banana productivity and temperature are examined, it is seen that 100% of the shocks in banana productivity in the first year are caused by itself. In the second year, 92.97% of the shocks in banana productivity are from their past shocks and 7.02% from the temperature variable; in the third year, 92.18% of the shocks in banana productivity are from their past shocks and 7.82% from temperature variable. It is seen that the relationship between the two variables loses its effect after two years.

When the variance decomposition results between apricot productivity and temperature were examined, it was seen that 100% of the shocks in apricot productivity in the first year were caused by itself. It was determined that 99.12% of the shocks in apricot productivity in the second year were caused by their past shocks and 0.88% were caused by the temperature variable; In the third year, it was concluded that 98.98% of the shocks in apricot productivity were caused by their past shocks and 1.01% by the temperature variable. In the fourth year, it was concluded that 96.82% of the shocks in apricot productivity were caused by their past shocks and 3.17% by the temperature variable. It is seen that the relationship between the two variables for four years disappeared.

When the variance decomposition results between cherry productivity and temperature are examined, 100% of the shocks in cherry productivity in the first year are caused by itself, while 95.89% of the shocks in cherry productivity in the second year are caused by their past shocks and 4.1% by the temperature variable. It is seen that the relationship between the two variables disappeared within one year.

When the results of variance decomposition between oat productivity and temperature are examined, 100% of the shocks in oat productivity in the first year are caused by itself, while 95.63% of the shocks in oat productivity in the second year are caused by their own past shocks and 4.36% are caused by the temperature variable. As can be seen from the results, it is seen that the relationship between the two variables disappeared within one year.

When the variance decomposition results between onion productivity and temperature are examined, it is seen that 100% of the shocks in onion productivity in the first year are caused by itself. 93.43% of the shocks in onion productivity in the second year are due to their own past shocks and 6.56% are due to the temperature variable. Between the third and tenth years, 75% of the shocks in onion productivity are caused by their own past shocks and 24.21% by the temperature variable. As can be seen from the results, the relationship between the two variables disappeared within two years.

When the variance decomposition results between potato productivity and temperature are examined, 100% of the shocks in potato productivity in the first year are caused by itself. In comparison, 97.59% of the shocks in potato productivity in the second year are caused by their past shocks and the temperature variable causes 2%.

Conclusion**:** In the study, the effect of climate change on the agricultural sector was revealed with econometric findings and analyzed with the Granger Causality Test. The study was based on the period of 1970-2017 for the agricultural sector. While the temperature average and precipitation average variables are taken as the basis as climate variables in the study, the productivity of the products selected for the agricultural sector is taken as the basis. In selecting agricultural products used in the study, the products that have an important place in Turkey's foreign trade were taken as a basis. According to the Granger Causality Analysis conducted in the study, it was concluded that there is a greater relationship between crop productivity and precipitation average than the average temperature. Since climatic factors depend on taking climate averages for many years, longer-term data are required to clearly reveal the effect on the productivity of agricultural products. The study was based on the period of 1970-2017, and although this period is not short, it is another point to be emphasized that there should be longer-term data to determine the effect of the average temperature on agricultural product productivity.

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